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CALIBRATING NACELLE LIDARS

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Introduction

Especially for offshore wind energy, nacelle mounted wind lidars will become an important tool for power performance verification. It has already been demonstrated that high quality power curves can be measured using the reference wind speed measurements from a nacelle lidar, completely eliminating the need for a measuring mast. For this to become established and accepted practice, one important step is to establish a calibration scheme so that the uncertainty of the measured power curve can be determined with reference to traceable standards. This paper describes an experiment undertaken to move towards the goal of a traceable nacelle lidar calibration.

Approach

Unlike a cup anemometer or a ground based wind lidar, for a nacelle lidar the flexibility of its mounting plays a significant role in its measurement accuracy. Tilting and rolling of the nacelle at the free end of the cantilevered tower is transferred directly to tilting and rolling of the nacelle lidar beams, changing their sensing heights. Determining the accuracy of the tilt and roll angles measured internally in the wind lidar is an important first step in a nacelle lidar calibration. A simple procedure for achieving this will be described.

Main body of abstract

For the actual wind speed measurement, we have chosen to calibrate the individual lines of sight and to measure the opening angle of the beams. These individual calibrations can be combined to give an overall calibration (and uncertainty) of the horizontal wind speed. Direct calibration of the horizontal wind speed would require a testing site with a high horizontal homogeneity. Since the testing has been performed close to the ground, even small changes in upstream fetch violate the requirement for homogeneity.

Our experimental method has been to mount the nacelle lidar on a convenient platform at 10m height and erect two 10m high masts close to the two beam positions at a range corresponding to around 2.5D for a multi-megawatt wind turbine. We have developed some novel techniques for identifying the lidar beam position in relation to the measurement masts. These techniques will be illustrated in the presentation. The lidar radial wind speed can then be compared to the wind speed measured from the top-mounted cup anemometer immediately adjacent to the beam, projected along the radial direction towards the lidar.

Conclusion

As for any remote sensor, it is important also to ascertain the accuracy of the sensing position. For a nacelle lidar , sensing too close to the rotor will result in a wind speed that is significantly reduced by the blockage of the rotor, resulting in an over-optimistic power curve. Our method is based on correlation of the lidar radial wind speed measurements to the tower-top cup anemometer. By finding the lidar range having the highest correlation to the cup, the true sensing range of the lidar can be verified.